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CONNECTICUT

AGRICULTURAL EXPERIMENT STATION

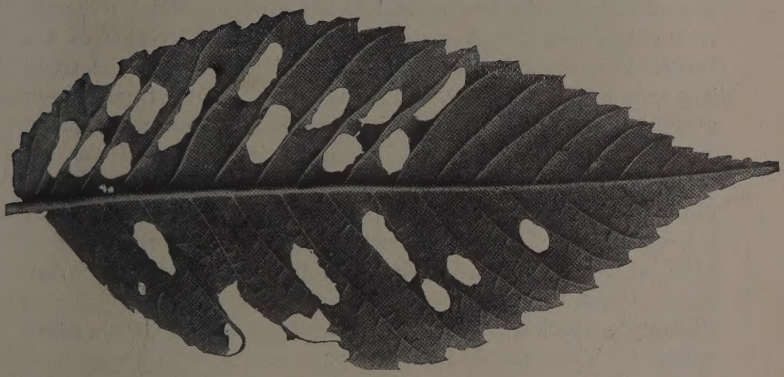
NEW HAVEN, CONN.

BULLETIN 155, MAY, 1907.

REVISED EDITION, APRIL, 1909.

ENTOMOLOGICAL SERIES, No. 14.

The Elm Leaf Beetle



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The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others as far as the editions permit.

THE ELM LEAF BEETLE.

Galerucella luteola Müll.

By W. E. Britton, *State Entomologist.*

During the past summer (1908) the elm trees of Connecticut have been injured more seriously by the elm leaf beetle than for several years. Many persons thought that the pest had run its course, and that never again would it do much damage to the shade trees of this part of the country. But they were mistaken. In some parts of the state, and especially along the coast, the elm trees were partially defoliated by canker worms in May, with more or less feeding, of course, by the adult elm leaf beetles. The canker worms disappeared about June 1st, and were followed immediately by the newly hatched larvæ of the elm leaf beetle, which devoured the green substance of the under side of the leaves, in many cases completing the defoliation of the trees. The season was a dry one, and though most of these trees put out a sickly growth of new leaves, it would have been much stronger in a wet season, and therefore less damaging to the trees.

Specimens of the elm leaf beetle were received from eleven different correspondents, representing the following parts of the state: Branford, Bridgeport, Ellington, Hartford, Meriden, Moosup, New Canaan, North Stonington, Rowayton and Wapping. From three of these localities (Branford, Meriden and Moosup), specimens of natural enemies of the beetle were received. These are discussed on page 9.

In addition to the samples received during the season, this office has received and answered fifty-five letters and many telephone calls regarding the pest. The inquiries came from all parts of the state, though most frequently from the southern half, Waterbury reaching first place in regard to the number of inquiries.

All things indicate a serious and destructive attack of the beetle the coming season. Now is the time to prepare for it. All trees losing their foliage in 1908 should be sprayed with poison this year or they may die. A portion of this paper appeared as Bulletin 155 in June, 1907, but a number of additions have been made to it as here given.

HISTORY AND DISTRIBUTION IN AMERICA.

The elm leaf beetle was introduced into this country probably more than seventy years ago. In its native country, Europe, where it had long been known, it had from time to time caused serious injury in Italy, Austria, and the southern portions of France and Germany. In Northern Europe the insect occurs sparingly, but can hardly be called a pest. Harris states* that the elm leaf beetle attacked and seriously injured the elm trees of Baltimore, Md., in 1838 and 1839. The beetle seemed to spread chiefly northward, though slowly, until Southern New England was reached in the early nineties, and much damage done. In the coast towns of Connecticut many fine old elms, including some historic trees, were killed by its depredations. Stamford, Norwalk, Bridgeport, Stratford, Milford and New Haven especially lost many noble trees. Later the inland cities were invaded, and the elm trees ravaged. In New Haven the pest was perhaps at its worst in 1895 and 1896. In 1896 many of the trees on the older streets about the center of the city were sprayed with poison by the street department. The following season the pest was less serious, and continued to subside until 1901, when it was again comparatively destructive. From 1902 it diminished in abundance until 1906, when considerable damage was done to the trees.

So far as is known the distribution of this insect in America is confined to the lower altitudes of Southern New England and the Alleghanian region. From Charlotte, N. C., its southern limit, the elm leaf beetle now extends as far north as North Conway, N. H. Up to this time, however, the beetle has done no particular damage in New Hampshire. Regions generally infested include the whole of Massachusetts, Rhode Island, Connecticut, Southeastern New York, New Jersey, Eastern Pennsylvania, Delaware, Maryland and a portion of Kentucky, though isolated outbreaks have occurred in Western New York, Pennsylvania, West Virginia, Ohio and North Carolina. It is of course found in Virginia, Vermont, New Hampshire, and probably in Maine. Kentucky, therefore, contains the western limit of the distribution of this insect, though we may expect that soon adjoining states may become infested. The insect exhibits a marked

* Insects Injurious to Vegetation, page 124.

tendency to spread farther along river valleys than over mountains, and is distinctly a pest of city and village trees rather than of trees in the open fields and roadsides of the country.

LIFE HISTORY AND HABITS.

The overwintering beetles come out of their winter quarters during the warm days of early spring, mate, and as soon as the leaves unfold they begin to eat small round or oval-shaped holes through them. Many leaves are thus riddled as though shot had been sent through them, and appear like the illustration on the cover of this bulletin.

During the latter part of May and early in June females deposit small clusters of yellow eggs on the under sides of the leaves. The period of ovipositing extends over about four weeks,

FIG. 1.—Larvæ and their work.

and each female may lay five or six hundred eggs. In about a week the eggs hatch and the young larvæ or grubs feed upon the under surface of the leaves, eating off the green tissue between the veins and leaving the veins and the upper epidermis, as is shown in fig. 1.

In about three weeks the larvæ or grubs are fully grown, and crawl down the trunks of the trees or drop from the ends of the branches to the ground and transform to the naked pupa stage. The great proportion of the pupæ are found close around the base of the tree or lodged in the crevices of the rough bark of the trunk and larger branches. Except for being in crevices, they are unprotected. The writer has seen trees in New Haven

where it would be possible to gather several quarts of these pupæ at the base of a single tree.

The pupa stage lasts about ten days, then the adult beetles appear, and lay eggs for the second generation, which seldom does much harm in Connecticut. Those emerging late probably do not lay eggs for a second brood, but may be seen crawling and flying about for a time, feeding more or less, but early going into winter quarters, usually in church belfries, attics of houses, barns, sheds or other out-buildings. They also pass the winter in cracks of fences, telephone poles, or under the edges of the loose bark of the trees. In some of the cities worst infested the adults sometimes gather in church belfries in such numbers that they

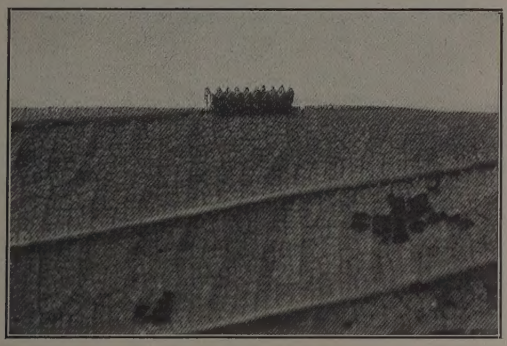

FIG. 2.—Cluster of eggs; greatly enlarged.

can be swept up by the half bushel. The elm leaf beetle often occurs with the two-spotted lady-beetle in dwellings, simply because they both seek the same kind of a place for hibernation. Correspondents frequently send both species to the writer and desire to know if they are not in some way responsible for the injuries to their carpets. There is, of course, no relationship or similarity in food habits of the three species. The lady-beetle is predatory, and in the larval stage destroys numbers of plant lice, and therefore should never be destroyed. The elm leaf beetles should, of course, be killed wherever they are found.

DESCRIPTION.

The *eggs* are bright yellow in color, bottle-shaped, and resemble the eggs of the Colorado potato beetle, but are smaller. They are fastened vertically to the under side of the leaf in clusters of from five to twenty-five arranged in two or three irregular rows and are shown in fig. 2.

When first hatched, the *larva* is dark or nearly black, covered with tubercles bearing black hairs. As the larva increases in size it molts several times and on becoming full grown is about one-half inch long, dull yellow in color, with a pair of longi-

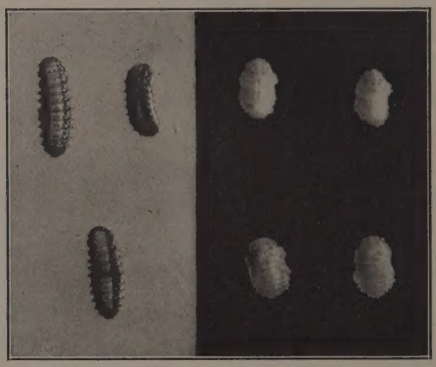

FIG. 3.—Larvæ and pupæ; twice natural size.

tudinal black stripes along the back. Head, legs, lateral tubercles and two rows of small tubercles between the dorsal stripes are black. The tubercles also bear black hairs. See fig. 3.

The *pupa* is about one-fourth inch in length and bright orange yellow in color, with black hairs or spines. It is not enclosed in an earthen shell to protect it, but is found at the base of the tree perfectly naked and wholly unprotected. See fig. 3.

The *adult beetle* is light yellow in color when it first emerges, but soon takes on a duller hue, and finally becomes a dull olive green. An indistinct black stripe extends from the base to the extremity of each wing-cover just inside of the margin. Small black spots or markings on the pronotum of the thorax vary greatly in size and shape. Legs and antennæ are yellow.

Adults are shown in fig. 4.

EFFECT UPON THE TREES.

It has previously been mentioned that the adult beetles do more or less feeding, always eating holes entirely through the leaves (see cover of this bulletin). This of course injures the tree, but is much less serious than the damage caused by the larvæ, which eat away the under surface of the leaves. The larvæ are always more abundant than the adult beetles, and are more voracious in their feeding habits. The worst infested trees usually drop their leaves in Connecticut about the middle of July. If this happens, and is followed by a rainy season, new leaves will be put out, but in a season of a protracted drought the trees may fail to put forth new leaves. In either case the tree is

FIG. 4.—Adult beetles; twice natural size.

FIG. 5.—The spined soldier bug, *Podisus maculiventris*, Say. Twice natural size.

undoubtedly weakened, and often seriously so. Sometimes the second crop of leaves is devoured by the second generation of beetles, but in Connecticut the white fungus mentioned in another part of this bulletin is apt to serve as an important check to the beetle in a wet season. Two complete defoliations, one succeeding the other, usually kill a tree. Usually, however, the defoliation is not quite complete, and the trees continue to exist in a greatly weakened and devitalized condition. In the cities and larger towns, on account of further injuries* by horses, by leaky gas pipes in the ground, and pavements which cut off the supply of moisture, many trees have died. In 1901 the writer was called to Norwich, where nearly every elm had died for a distance of about one and one-half miles on a prominent residential street.

*For a discussion of these injuries the reader should consult Bulletin 131 of this station.

These trees had been weakened by the constant attacks of the beetle year after year, and a leaky gas main finally destroyed what little vitality remained. Most of the maple trees along the street survived.

In many cases young or newly planted trees seem to be especially subject to attack, and therefore should receive extra attention.

FOOD PLANTS.

Elms constitute the only food plants known for this insect, and the European species suffer more than the American ones. The English elm (*Ulmus campestris*) and its weeping variety known as the Camperdown elm are favorites of the beetle. The writer has seen these trees entirely defoliated in New Haven when the common white, or American elms, were uninjured. The American elm is, however, the next choice, followed by the Scotch elm (*U. montana*), and though no variety is wholly exempt from attack, the winged elm (*U. alata*), the slippery elm (*U. fulva*), the cork elm (*U. suberosa*) and the rock elm (*U. racemosa*) are much less frequently attacked.

NUMBER OF GENERATIONS.

According to Burgess,* "in New Jersey, Professor J. B. Smith has recorded only a single brood and sometimes a partial second brood, while in the latitude of Washington, D. C., according to the observations of Messrs. Riley, Howard and Marlatt, of the Division of Entomology, two annual broods and sometimes a partial third brood have been found."

Dr. E. P. Felt, state entomologist, of Albany, N. Y., finds† two well-marked broods and a partial third brood at Albany and Troy, N. Y.

The writer has not followed out this matter carefully in Connecticut, but all stages are found on the trees during the first half of September, so presumably there are at least two broods, but the egg-laying period of the adults is so prolonged that the lines of demarcation are nearly obliterated. In Connecticut the leaves of the trees severely attacked by the first brood generally turn brown and drop about the middle of July, when the larvæ are descending the trees to pupate.

* Bulletin No. 4, page 17, Ohio Dept. of Agriculture, Div. of Nursery and Orchard Inspection, 1905.

† Bulletin No. 57, N. Y. State Museum, p. 14, 1902.

NATURAL ENEMIES.

One of the most important natural enemies of the elm leaf beetle in Connecticut is a fungus known to botanists as *Sporotrichum globuliferum* Speg. (*S. entomophilum* Peck), which attacks the pupæ and adults in late summer, especially in a moist season. In 1902 this fungus was prevalent, and the following season the elm leaf beetle did little damage to the trees. In 1906 the beetles were abundant, but as the month of July was wet, the fungus developed and killed a great many beetles. Beetles attacked by this fungus are covered with white mold, as shown in fig. 6.

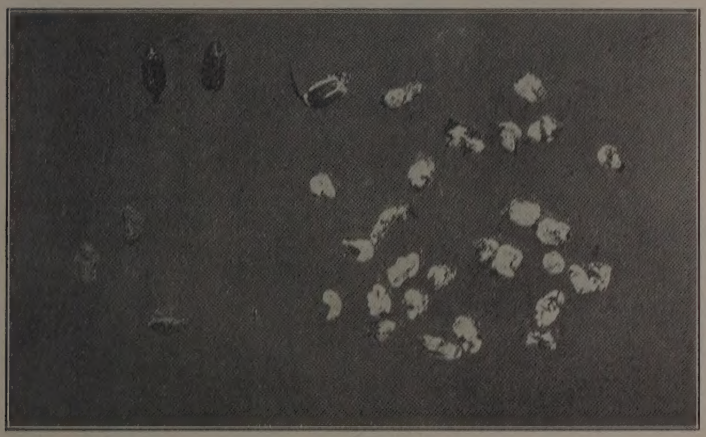

FIG. 6.—Pupæ and adults killed by fungus. Healthy specimens at the left, natural size.

In 1907 the elm leaf beetle, though doing some damage throughout the state, was much less serious than in 1906, but an extreme drought prevailed, almost no rain falling during July and August, and the fungus could not get in its work. Consequently most of the beetles matured and transformed, and were ready to attack the trees in 1908, doing serious damage. It was also very dry in 1908, and the *Sporotrichum* could not prevail. After a light rain late in July the writer saw a number of infested pupæ and adult beetles, but it was after most of them had transformed and the beetles flown away, and the rain soon dried up,

making it impossible for the fungus to continue to develop. These conditions indicate, therefore, that the pest will be abundant and destructive next year, and all citizens should be ready to combat it.

The writer believes that the fungus just mentioned constitutes an important check on the beetle in seasons when there is much moisture at the time of pupation, and this view is also shared by Dr. G. P. Clinton, botanist of this station, who has observed its work in this vicinity.

In Europe there is a minute chalcidid parasite known as *Tetrastichus xanthomelænæ* Rond. which attacks the eggs of the elm leaf beetle, and at times proves an effective check. After many trials, this parasite has during the past season been introduced into this country through the efforts of Dr. L. O. Howard,* and has been distributed in Massachusetts, New York, New Jersey, and at Washington, D. C. It is hoped that it may survive here and prove an important aid in controlling this pest.

Predatory bugs of at least three species of the genus *Podisus*, called "soldier bugs," feed upon the larvæ and pupæ, and one of these, *P. maculiventris* Say (formerly *P. spinosus* Dall.), the spined soldier bug, was unusually abundant during 1908 and destroyed many larvæ, pupæ, and adult beetles, though of course the proportion destroyed is very small. The spined soldier bug was sent in from Branford, where its attack on the beetles was observed by Mrs. A. J. Tenney; from Meriden and from Moosup, where it had also been found preying upon the elm leaf beetles. From Bridgeport dead beetles were received, having been killed by one of these bugs. The writer observed a number of cases in New Haven where larva, pupa or adult had been attacked by the spined soldier bug, which impaled the victim upon its proboscis and waved it about in the air while sucking out the juice. These bugs were rather common on trees during the last of July and the first part of August, and are shown in fig. 5 and their work in fig. 7. Dr. A. W. Morrill† has published a record of two of these bugs in confinement which during their last nymphal stage destroyed twenty-six elm leaf beetle larvæ, and after becoming adults destroyed two hundred and twenty elm leaf beetle larvæ and seven large caterpillars.

* Journal of Economic Entomology, Vol. I, p. 281, October, 1908.

† Bulletin No. 60, Bur. of Entomology, U. S. Dept. of Agriculture, p. 155. 1906.

Riley records* two species of beetles, *Platynus punctiformis* and *Quedius molochinus,* as preying upon the elm leaf beetle, and states that an assassin bug, *Reduvius novenarius,* sucks the juices of both adults and larvæ upon the leaves, and that the larva of a species of *Chrysopa* feeds upon the eggs.

The praying mantis (*Stagmomantis carolina* Linn.) is also an enemy of the elm leaf beetle in the southern portion of its range.

Birds of various kinds are known to feed upon the beetles in their larval, pupal and adult stages. Some of the creepers have been observed apparently feeding upon the pupæ.

FIG. 7.—Adult beetles killed by the spined soldier bug.

REMEDIES.

Spraying with poison. Covering the foliage with some arsenical poison is the only sure means of preventing injury to the trees, and for this purpose arsenate of lead is unquestionably the most satisfactory of these poisons. It remains better in suspension and adheres to the foliage longer than Paris green or London purple, and is less liable to injure it. As there are now several brands

* Bulletins No. 6, p. 10, and No. 16, p. 13, Bur. of Entomology, U. S. Dept. of Agriculture.

of good arsenate of lead on the market, it will no longer pay to make it up each time from lead acetate and arsenate of soda. The standard brands of lead arsenate on the market are as a rule satisfactory and many of them have been used in our tests. If anyone desires to know the chemical composition of these preparations he should consult Bulletin 157, or the Report for 1907, p. 323, of this station, both of which give the analyses of most of the brands which were sold on the market in 1907. Since then a few new brands have been added, some of which have been examined here. It is fair to state that it is safe to purchase any of them if made by well-known and reliable firms, though as the published analyses show, there is considerable difference in the value on account of the composition and each purchaser should obtain guarantees and prices before buying in large quantities. There are also certain differences in mechanical condition which should be considered. Arsenate of lead should be used in the following proportions:—

Formula	Arsenate of lead	3–5 lbs.
	Water	50 gals.

There are two methods of spraying elms: (1) To spray as soon as the leaves unfold, the treatment being aimed especially at the parent beetles, and to forestall all injury. This treatment should be practiced wherever canker worms are destructive. As growth takes place, new leaves are constantly appearing, and these will not carry poison unless the application is from time to time repeated. This should be done often enough to keep the foliage well coated with poison until July 1st, when growth usually ceases, and both sides of the leaves should be coated.

(2) The other method is to spray the under sides of the leaves very thoroughly about June 1st, or soon after the eggs begin to hatch. This treatment is aimed at the larvæ, and sometimes a single spraying is sufficient, as the poison will remain throughout the season. By it the great bulk of damage will be prevented, but the leaves will show the small holes made by the parent beetles before the poison was applied.

If arsenate of lead cannot be procured and it seems desirable to use other poisons, Paris green can be substituted.

This should be used at the following rate:

Formula	Paris Green	1 lb.
	Fresh lime	3 lbs.
	Water	50 gals.

Paris green is quicker in its action upon the insects than arsenate of lead, but will not remain as long upon the trees. Unless the lime is added, there is danger of "burning" the leaves. Lime is not needed with arsenate of lead.

The cost of spraying elm trees will vary from ten cents each in case of small trees to five dollars or more for the largest trees, according to the price of labor and the efficiency of the outfit.

Destroying the pupæ. If the trees have not been protected by spraying, and have been attacked and injured by a horde of beetles and their larvæ, it is always advisable to destroy the insects in the pupa stage at the base of the trees, in order to reduce the crop for next year as much as possible. These can often be swept up in large quantities; they can be killed by sprinkling them with hot water; but best of all is to spray the ground not only close to the tree but as far away as the branches reach, and also spray the bark of the trunk and large branches, with kerosene emulsion or some other contact insecticide. The pupæ are easy to kill, but as they remain in the pupa stage only about ten days, it is essential that this work be done at the right time, and it is only when we observe that most of the larvæ descending the trunk have transformed to bright yellow pupæ that we can know when is the proper time to act.

Destroying the adult beetles. The beetles should of course be destroyed in attics, belfries and other places where they hibernate. This can best be done by sweeping them up before they become very active in spring and dropping them into the fire, hot water or kerosene to kill them.

OUTFIT FOR SPRAYING ELM TREES.

The barrel hand-power pump can be used for spraying small trees or for a limited number of large trees, but if one expects to make a business of spraying street trees, it will pay to procure a power sprayer; this may be a steam or gasoline engine with pump; and still another kind is the "Niagara Gas Sprayer," which utilizes cylinders of carbonic acid gas to furnish pressure, thus doing away with a pump. Each large village and city should have at least one power sprayer that can be put to immediate use for spraying street or park trees. Strong one-half inch hose should be provided in long lines of from fifty to two hundred

feet, and from four to six of these can be attached to each power sprayer. Even a larger number might be attached, but while in operation some workmen would be in the way of others, so that nothing would be gained. Mr. H. L. Frost of Boston, who is in the spraying business, informed the writer that four lines of hose is about the most economical number for each outfit. Each hose is furnished with an extension rod with closing valve at the lower end and a cluster of nozzles at the upper end. These rods should be of different lengths, from four to twelve or fourteen feet for the different kinds of work. Any of the standard nozzles such as "Vermorel," "Mistry," or "Spraymotor" will be found satisfactory, and if several are used together in a cluster one is able to cover more leaf surface in a given time.

For getting about in tall trees it will be necessary for the men to be provided with climbing irons and extension ladders.

SUMMARY.

The elm leaf beetle was introduced into this country from Europe about seventy years ago, and caused serious injury to trees at Baltimore, Md., in 1838 and 1839. From this point it spread slowly, chiefly to the northward, reaching Connecticut in the early nineties, and injuring and killing many fine old trees in the coast towns. Later, inland towns were attacked, and the trees ravaged. The insect is now found from Charlotte, N. C., as far north as North Conway, N. H., and as far west as central Kentucky, but has not proven destructive to elm trees north of Massachusetts. It is preëminently a pest of shade trees in cities and towns, and seldom injures trees in the open fields. Since 1896 the attacks have diminished, but the pest was again serious in 1906.

The winter is passed by the adult beetles in attics, belfries and cracks in fences, and they come forth in April, and later feed and lay their yellow eggs upon the unfolding leaves. Beetles eat holes through the leaves, eggs hatch in a week, and the larvæ eat off the green tissue from the under surface, causing the leaves to turn brown and fall about the middle of July, at which time the larvæ are about full grown. Then they descend to the base of the tree and transform to naked pupæ; ten days later the adult beetles emerge and lay eggs for the second brood or go early into winter quarters.

Two complete defoliations in succession will kill a tree.

How to Fight the Elm Leaf Beetle.

1. Search all attics, church belfries and cupolas for the dormant beetles in winter and early spring. Sweep them up and burn them.

2. Spray the leaves with poison as soon as they have opened, if their shot-hole appearance shows that the beetles are there in abundance, and the under sides of the leaves should be coated about June 1st to destroy the larvæ or grubs.

3. When, later in the season, the yellow pupæ appear on the trunks of trees and the ground beneath, kill them with a spray of kerosene emulsion or by sweeping them up and burning or soaking with kerosene.

The first and third measures should be taken by each householder, church or social organization, at individual expense. The spraying, which is difficult and expensive if the trees are large, can only be done by concerted action of the town or borough authorities. For extensive spraying work power sprayers are desirable, but small elms or a few large trees can be treated successfully by means of a hand-pump of barrel size. The "Niagara gas sprayer" in operation is shown in fig. 8.

FIG. 8.—"Niagara Gas Sprayer" and Outfit for Spraying Street Trees. (After Smith, Rep. N. J. Expt. Sta. 1905.)